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# 24. Pricing in Bertrand competition with increasing marginal costs

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**Abstract**

Bertrand competition under decreasing returns involves a wide interval of pure strategy Nash equilibrium prices. We first present results of experiments in which two, three and four identical firms repeatedly interact in this environment. More firms lead to lower average prices. However, prices remain substantially above the Walrasian level. With more than two firms the predominant market price is 24, a price not predicted by conventional equilibrium theories. This phenomenon can be captured by a simple imitation model and by a focal point explanation. For the long run, the model predicts that prices converge to the Walrasian outcome. We then use data from three new treatments to properly test the influence of imitation and focality. We find that both forces are present, but that imitation dominates in large markets with a long interaction.


*JEL classification:* C90; C72; D43; D83; L13

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## 1. Introduction

In this paper we present an experimental study of Bertrand competition under decreasing returns as well as a theoretical model of the behaviour we observe. Part of our motivation is to contribute to delineating a more complete picture of oligopolistic behaviour from an experimen-

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tal viewpoint. In particular, we are interested in how price and efficiency levels depend on the number of firms. With respect to price levels we wish to find out whether they remain above Walrasian levels with three or four firms.

There is, however, a second more conceptual rationale for our work. The oligopoly setting we investigate is based on a large co-ordination stage game with many Nash equilibria, so that *a priori* actual behaviour is hard to pin down theoretically. A good part of our paper, hence, deals with the formulation and testing of a model that can explain our data. We believe that the insights from this effort reach beyond the particular price competition model we study. Laboratory experiments are well suited for investigating problems of multiplicity of equilibria; they may be able to supply precise predictions on the basis of a variety of behavioural factors. Examples of the use of experiments in contexts with Nash equilibrium multiplicity are Van Huyck et al. (1990), Brandts and Holt (1992) and Cooper et al. (1990).

How the number of firms affects prices when there are only few competitors in the market is one of the central themes of the economic analysis of oligopoly. Theoretical analysis has provided some answers to the above question. The equilibrium proposed by Cournot (1838) for the case of quantity competition yields predictions of a unique price and of a price-cost margin which is decreasing in the number of firms. For the case of price competition Bertrand's (1883) analysis led to somewhat less natural predictions for the case of constant returns and no capacity constraints: With more than one firm prices will be equal to marginal cost, independently of the number of firms.

Economists' stylised view of oligopolistic competition has been complemented by experimental studies on the subject. Numerous studies report results from quantity competition environments. Huck et al. (2004) provide a recent survey and synthesis of experimental work on quantity competition. Their conclusion is that duopolists sometimes manage to collude, but that in markets with more than three firms collusion is difficult. With exactly three firms, Offerman et al. (2002) observe that market outcomes depend on the information environment: Firms collude when they are provided with information on individual quantities, but not individual profits. In many instances, total average output exceeds the Nash prediction and furthermore, these deviations are increasing in the number of firms. The price-cost margins found in experimental repeated quantity competition are, hence, qualitatively consistent with the Cournot prediction for the static game.

Dufwenberg and Gneezy (2000) study the effects of the number of firms in a standard Bertrand competition framework with constant marginal cost and inelastic demand. In their experiments, price is *above* marginal cost for the case of two firms but equal to that cost for three and four firms. Their results just modify in a simple way the view that one can take the Bertrand equilibrium as a prediction: by changing from two to three the number of firms from which on the price can be expected to equal marginal cost.[1]

Price competition leads to different predictions in other settings. Dastidar (1995) analyses price competition in a model in which firms operate under decreasing returns to scale and have to serve the whole market. The apparently small move from constant to increasing marginal

[1] Further experiments on price competition include Davis and Holt (1994), Kruse et al. (1994) and Morgan et al. (2006). These three studies consider environments with mixed strategy equilibria, and find price dispersion qualitatively similar to the relevant equilibrium.